

IST PENN STATE Presented at the ACT-R 2003 Workshop.

Using Cognitive Modeling to Study Behaviour Moderators: Pre-task Appraisal, Anxiety, and Later, Caffeine

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Motivation for Modeling Moderators

- Modeling cognition and affect including stress (multiple behavioral moderators that influence architecture processing)
- Important for modeling aspects of human-computer interactions
- Extending computer-generated forces
- Example validated model

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Acknowledgements

- Susan Chipman provided support and anxiety suggestion.
- Wayne Gray and Roman Belavkin have helped develop our thinking in this area.
- Marsha Lovett provided WM task

This project was supported by the US Office of Navy Research, award number N000140110547 and by the Space and by the Naval Warfare Systems Center, San Diego, No. N6600-01-1-8916.

The views expressed in this article do not necessarily reflect the positions or the policies of the U.S. Government, and no official endorsement should be inferred.

Not enough stress	Not enough stress	Not enough stress	Almost enough stress
Perhaps enough stress	Enough stress	Leaning towards too much stress	Somewhat likely too much stress
Perhaps too much stress	Maybe too much stress	Probably too much stress	Quite likely too much stress
Very likely too much stress	Extremely likely too much stress	Almost assuredly too much stress	Too much stress

Our Approach

- Cognitive architecture (ACT-R)
- Biopsychology models and data
- Validation of model's behavior
- Displays to explain model to
 - > analysts
 - > readers

ACT-R Model of Serial Subtraction

- Create goal to serial subtract
 - > Subgoal to do current column
 - Two strategies: count-down and subtract
 - Get column answer
 - > Repeat across columns
 - > Report result
- 28 rules
- 15 state chunks + 230 math facts
(~250 total chunks)

acs.ist.psu.edu/ACT-R_AC

Subtraction Data: Neutral and Non-neutral Appraisal

- Subtask of many military tasks
- Relevant data to hand
 - % correct from article and attempts
- Problem is that we will need more detailed data with moderators active
 - > Typically, with moderators active only gross performance measures are taken

Data to Be Modeled: Challenge Appraisals

- Pre-task appraisal and Caffeine
 - » Important effects in humans
- “Challenge” pre-task appraisal:
 - > incr. heart rate, incr. sympathetic arousal, vascular dilation: good energy mobilization (fight-or-flight)
 - > incr. subtraction attempts
 - > incr. percent correct responses

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Data to Be Modeled: Threatening Appraisals

- “Threatening” pre-task appraisal
 - > modest incr. heart rate, modest incr. sympathetic arousal, vascular constriction, poor energy mobilization
 - > decr. subtraction attempts
 - > decr. percent correct responses

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Subtraction Model (challenge)

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	Its Effect	Overlay Implementation
Pre-task appraisal	Challenge leads to more attempts, less errors	Decrease Expected-Gain-Noise (0.1) Increase circulation, generally *
	Threat leads to fewer attempts, more errors	Increase Expected-Gain-Noise (1.0) Complex changes in circulatory system *
Anxiety	Same as threat	Rule fires, using time and decreasing working memory activation
Caffeine	Increased alertness with inverted U-shaped curve	Affects threshold at end of 4 min. run for Challenging post-task appraisal*
	At moderate doses decreased RT	Indirect through task appraisal*
	Exacerbate the effects of anxiety	Decrease error threshold needed for post-task appraisal being "threat"

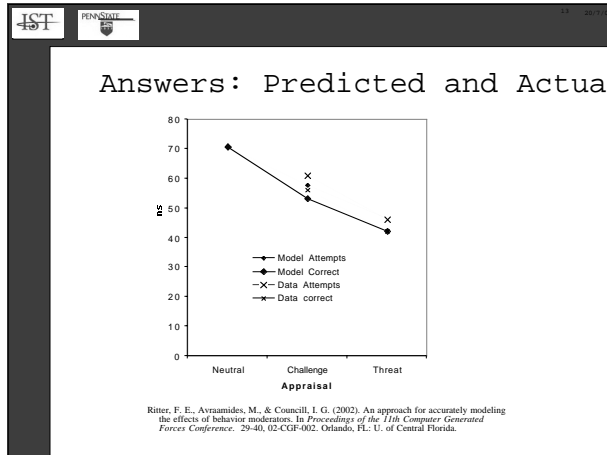
* Indicates not in released version.

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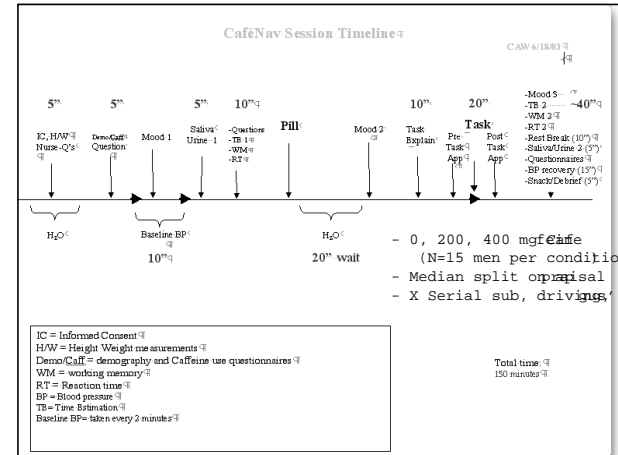
Subtractions: Predicted and Actual

Pretask appraisal :		Challenge	Threat	Neutral
Simulation (N=10)	Attempts	57.6	> 46.2	< 70.7
	Number correct	53.2	> 42.1	< 70.7
		92%	91%	100%
Simulation with Worry (N=10)	Attempts	43.2	> 37.2	< 59.3
	Number correct	37.9	> 32.6	< 59.3
		88%	88%	100%
Tomaka et al. (1993)	Attempts	61	> 46	n.a.
	Number correct	56	> 42	n.a.
		92%	91%	

Ritter, F. E., Avramides, M., & Council, I. G. (2002). An approach for accurately modeling the effects of behavior moderators. In *Proceedings of the 11th Computer Generated Forces Conference*, 29-40, O2-CKP-002, Orlando, FL: U. of Central Florida.



- ### Data to Be Modeled: Caffeine
- Qualitative performance: an inverted U-shaped curve:
 - > Low and high levels of caffeine --> poor performance
 - > Moderate levels of caffeine --> optimal performance
 - Quantitative measures with this task needed from future study
 - Also need a mapping from data to theory



- ### Application to Existing Interfaces: 3D Driving and Argus
- Direct interface
 - With "Inside-out" driving
 - Driving behavior
 - Real-time
 - Interactive environment
 - Extensible code
 - Environment
 - Interface
 - Works with unmodified 3D Driving Game
 - » Perception influences task, and also task appraisal

Distributed Code

- [acs.ist.psu.edu /ACT-R_AC](http://acs.ist.psu.edu/ACT-R_AC)
- Overlay includes: model, worry dual-task, interfaces, traces, pictures, movies
- Leaves out internal, physiology variables

Open Questions / Conclusions

- ACT-R's model library is not yet large enough to cover tasks (about 1/4 of published 'available')
- ACT-R at 'normal' is too good, rule choice is perfect
- How to overlay multiple overlays?